



Coimisiún na Scrúduithe Stáit State Examinations Commission

LEAVING CERTIFICATE EXAMINATION, 2025

ENGINEERING – MATERIALS AND TECHNOLOGY

(Higher level – 300 marks)

THURSDAY, 5 JUNE

MORNING 9:30 – 12:30

The 2025 examination papers were adjusted to compensate for disruptions to learning due to COVID-19. This examination paper does not necessarily reflect the same structure and format as the examination papers of past or subsequent years.

INSTRUCTIONS

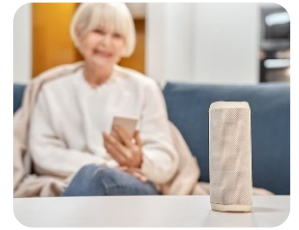
1. Answer **any SIX** questions.
2. All questions carry equal marks.
3. All answers must be written in ink on the answer book supplied.
4. Diagrams should be drawn in pencil.
5. Squared paper is supplied for graphs, as required.
6. Please label and number carefully each question attempted.

Question 1.

(50 marks)

Give **brief** answers to **any ten** of the following:

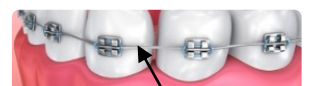
- (a) Outline **two** advantages of *voice recognition technology*.
- (b) Explain the function of a *heatsink* in electronic devices.
- (c) State **two** safety precautions to be observed when using cutting fluids.
- (d) Outline **two** reasons why cast iron is often used to manufacture a kettlebell, as shown opposite.
- (e) Discuss the contribution that **any one** of the following has made to technology:
 - (i) Michael Faraday (ii) Pierre Vernier (iii) Francis Beaufort.
- (f) Identify **two** benefits of recycling plastic bottles and aluminium cans for the Deposit Return Scheme (DRS), introduced in Ireland in 2024.
- (g) Distinguish between *incremental* and *absolute* dimensioning.
- (h) Outline **two** reasons why anodised aluminum is suitable for the manufacture of the climbing carabiner shown.
- (i) The climbing carabiner is designed with a high factor of safety. Explain the term *factor of safety*.
- (j) Identify **any two** lathe processes used to manufacture the *screw lock* of the climbing carabiner shown.
- (k) Outline the operation of an electromagnet.
- (l) State **two** benefits of pneumatic powered equipment used by a dentist.
- (m) Describe **two** critical properties to be considered in the selection of stainless steel as a wire material in the dental braces shown.



climbing carabiner



screw lock



wire dental
braces

Question 2.

(50 marks)

Answer **all** of the following:

- (a) The need to develop alternatives to fossil fuels is a significant global challenge.
- (i) State the main properties of hydrogen.
- (ii) Describe **two** advantages of using hydrogen as a fuel source.

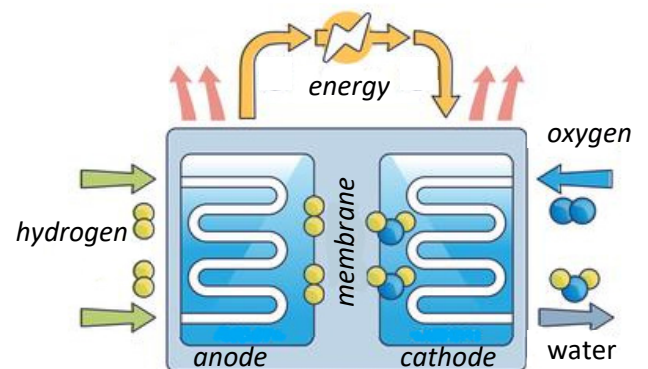


- (b) Steam Methane Reforming (SMR) accounts for 95% of global hydrogen production. It is regarded as efficient and cost effective.
- (i) Describe the process of SMR.
- (ii) Outline the environmental impact of SMR with reference to the use of fossil fuels, energy input and emissions.



- (c) The Government of Ireland *National Hydrogen Strategy (2023)* has identified enhancing our energy security and creating export market opportunities as key future strategies.
- (i) Outline **two** reasons why Research and Development (R&D) is important in hydrogen energy technology.
- (ii) Distinguish between the use of hydrogen power for data centres and agricultural industries.

- (d) Outline the principle of operation of a hydrogen fuel cell with reference to the anode, cathode, electrolyte membrane and by-products.



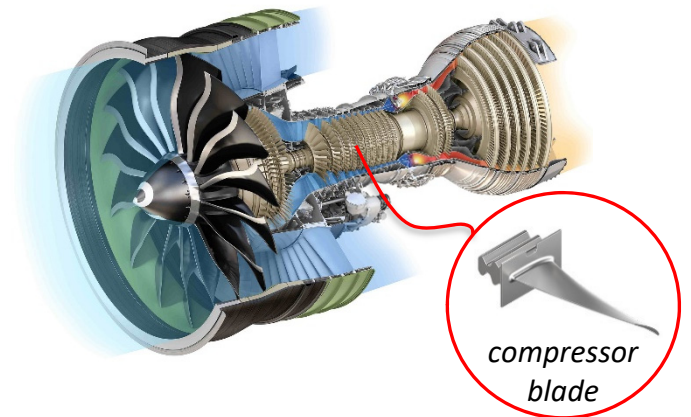
- (e) Discuss, with examples, the challenges of **any two** of the following aspects associated with the expansion of hydrogen technologies:
- (i) The production of green hydrogen.
- (ii) Energy storage.
- (iii) Safety concerns.

Question 3.

(50 marks)

- (a) The compressor blades used in the jet engine shown are manufactured from nickel-based superalloys. These superalloys have a high resistance to deformation from thermal creep and metal fatigue.

- (i) Explain the term *metal fatigue*.
- (ii) Describe how temperature may affect creep in metals.
- (iii) Describe, with the aid of a diagram(s), the principles of tensile testing.



- (b) The results shown below were obtained from a tensile test carried out on an alloy test specimen, with a diameter of 12mm and a gauge length of 80mm.

Load (kN)	30	80	126	147	154	148	152	162	180	175
Extension (mm)	0.2	0.5	0.8	0.9	1.5	2.0	2.5	3.0	5.5	8.0

- (i) Using the graph paper supplied, plot the load-extension diagram for the alloy.
 - (ii) Indicate **each** of the following points on your graph:
 - Elastic limit
 - Start of necking
 - Fracture point.
 - (iii) Determine the Ultimate Tensile Strength (UTS) of the specimen.
- (c) Non-destructive testing (NDT) plays a vital role in the design, manufacture and maintenance of aircraft parts.
- (i) Distinguish between microscopic and macroscopic non-destructive testing.
 - (ii) Describe, with the aid of a diagram(s), **one** suitable non-destructive test used to examine jet engine turbine blades for internal flaws.

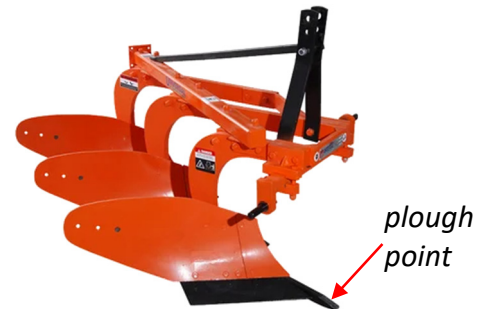


Question 4.

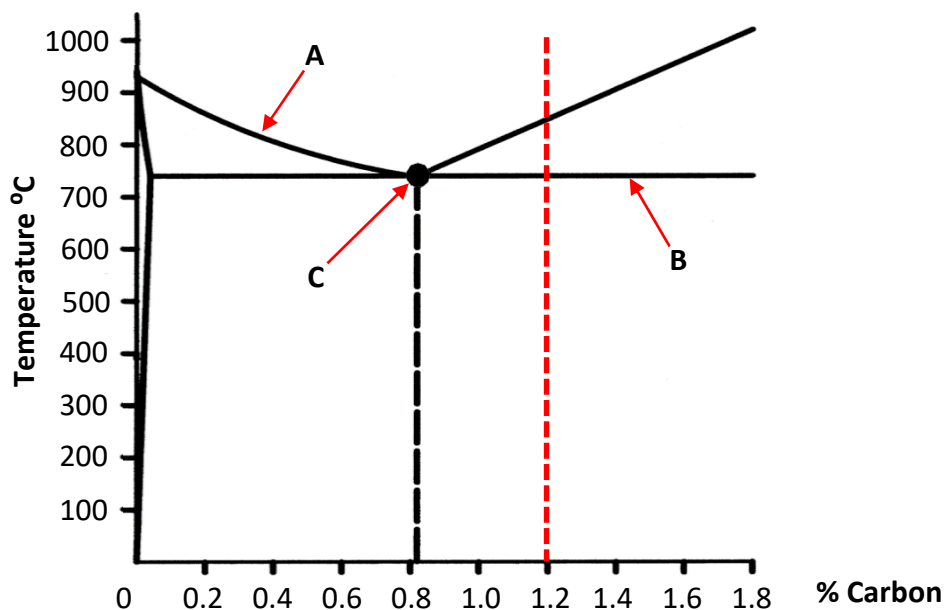
(50 marks)

(a) Agricultural machinery, such as the plough shown, is subject to surface hardening techniques during manufacture.

- (i) Outline **two** reasons for surface hardening the plough point.
- (ii) Describe, with the aid of a diagram(s), the heating and cooling process used during the induction hardening of the plough point.



(b) A simplified portion of the iron-carbon equilibrium diagram is shown.



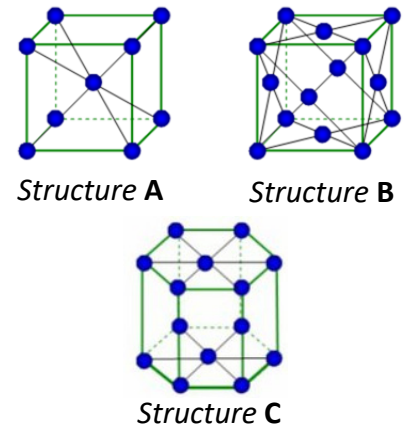
- (i) Name the transformation line **A** and the transformation line **B**.
 - (ii) Name point **C** and describe the transformation which occurs at this point.
 - (iii) Describe the annealing of 1.2% carbon steel under the following headings:
 - Temperature
 - Cooling process
 - Effect on the steel.
- (c) Answer **any two** of the following:
- (i) Describe, with the aid of a diagram(s), the operation of an optical pyrometer.
 - (ii) Identify **any three** quenching media used in heat treatments.
 - (iii) Explain **one** benefit of forging metal components.

Question 5.

(50 marks)

(a) Metals can exist in a number of forms including allotropes and alloys.

- (i) Explain the term *allotrope*.
- (ii) Identify **each** of the crystal structures **A**, **B** and **C** shown.
- (iii) With reference to the allotropy of iron, outline the difference between the properties of structure **A** and the properties of structure **B**.



(b) The table shows the solidification temperatures for various alloys of Cadmium and Zinc.
The melting temperature of Cadmium is 321°C and the melting temperature of Zinc is 419°C.

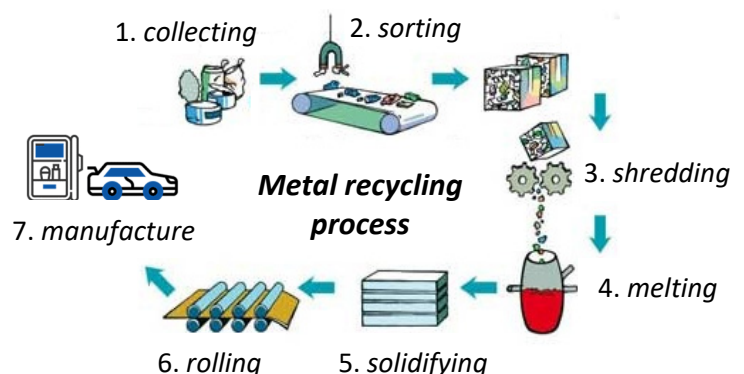
% of Zinc in alloy	10	14	20	30	40	50	60	70	80	90
Start of solidification (°C)	290	266	275	293	310	328	345	362	380	401
End of solidification (°C)	266	266	266	266	266	266	266	266	266	266

Using the graph paper supplied:

- (i) Draw the equilibrium diagram according to the given data **and** label the liquidus and solidus lines.
- (ii) For the alloy with **60% Zinc**, determine from the diagram the ratio of the phases at **300°C**.
- (iii) Name the transformation point for the alloy containing **14% Zinc** at **266°C** and describe what occurs at this point.

(c) Answer **any two** of the following:

- (i) Describe **any four** of the stages in the metal recycling process shown.
- (ii) Outline **two** benefits of upcycling metal components.
- (iii) Explain the electrometallurgy of aluminium.



Question 6.

(50 marks)

(a) Submerged arc welding (SAW) is used to fabricate segments of rolled steel to form the structural towers of wind turbines.

- (i) Describe, with the aid of a diagram(s), the process of submerged arc welding (SAW).
- (ii) State **two** reasons why submerged arc welding (SAW) is used in the fabrication of wind turbine towers.



(b) Answer **any three** of the following:

- (i) Identify **two** necessary steps in the preparation of a joint for welding.
- (ii) State **two** functions of the electrode coating in manual metal arc welding.
- (iii) Describe how acetylene gas is safely stored.
- (iv) Describe, with the aid of a diagram(s), the process of friction welding.
- (v) Outline how *distortion*, as shown, may occur during welding.



(c) Compare, with the aid of suitable diagrams, resistance spot welding **and** resistance seam welding, using the following headings:

- Electrode shape
- Welding procedure
- Safety considerations
- Applications of each weld type.

OR

(c) Modern welding techniques are using Artificial Intelligence (AI) and Virtual Reality (VR).

- (i) Outline **two** benefits of using Artificial Intelligence (AI) to inspect welds for defects.
- (ii) Describe **two** advantages of using Virtual Reality (VR) headsets during welder training.



Question 7.

(50 marks)

- (a) Plastic barriers are commonly used to direct traffic and to keep pedestrians safe at road works and building sites. The barriers shown are hollow and are made from thermoplastic high-density polyethylene (HDPE).

- (i) Give **two** reasons why the barriers shown are hollow in design.
- (ii) Describe, with the aid of a diagram(s), a **suitable** polymer manufacturing process for the hollow barriers shown.
- (iii) Outline **two** properties of high-density polyethylene (HDPE) which make it suitable for the manufacture of the barriers.



hollow plastic barriers

- (b) Answer **any three** of the following:

- (i) Outline **two** reasons why carbon composite materials are used in the manufacture of body panels for the eVTOL aircraft shown.
- (ii) Explain the difference between *elastic memory* and *elasticity* in thermoplastics.
- (iii) Outline the function of a *catalyst* **and** an *inhibitor* in the addition polymerisation process.
- (iv) Discuss the use of *foaming agents* in polymer manufacturing.
- (v) Identify **two** reasons why *polyurethane* is suitable for use in the manufacture of skateboard wheels.



- (c) The *Seabin™* is an innovative floating device, designed to remove plastic waste and other debris from the surface of water.

- (i) Outline the effects of plastic waste on marine life.
- (ii) Differentiate between the methods of recycling *thermoplastics* and *thermosetting plastics*.



Seabin™

Question 8.

(50 marks)

- (a) Precision surface grinding produces highly accurate parts for use in medical devices, such as the hip joint implant shown.

- (i) Describe, with the aid of a diagram(s), the precision surface grinding process.
- (ii) Outline **two** safety hazards associated with using a precision grinding machine.

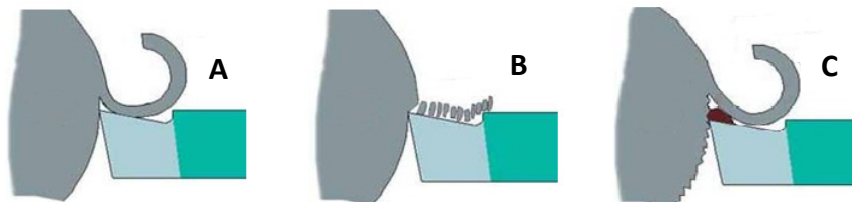


- (b) Answer **any three** of the following:

- (i) Explain, with the aid of a diagram(s), the difference between a *dovetail* cutter and a *T-slot* cutter used in milling.
- (ii) Outline **two** advantages of using tungsten carbide insert tips over high-speed steel in cutting tools.
- (iii) Describe **two** methods used to prolong cutting tool life.
- (iv) State **two** benefits of laser measuring systems in CNC machining.
- (v) Identify **two** precautions that should be taken to prevent *rancidity* in cutting fluids.



- (c) Machining on the lathe produces metal chips, such as those illustrated at **A**, **B** and **C** shown.



- (i) Identify the metal cutting chips shown at **A** and **B** and distinguish clearly between them with reference to material properties.
- (ii) Identify the chip formation shown at **C** and outline how this chip formation impacts on both safety and surface finish.

OR

- (c) The robotic arm shown combines the flexibility of a 6-axis robot with CNC milling technology.

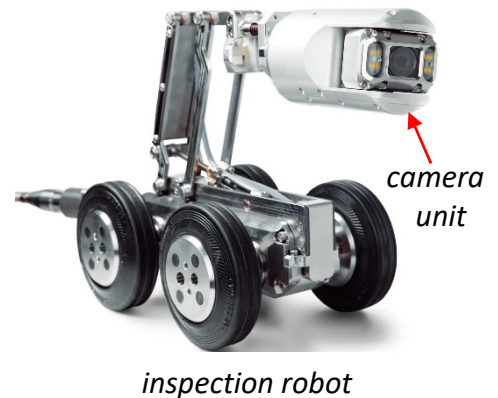
- (i) Describe **each** of the following in relation to robotic CNC milling technology:
 - Stepper motors
 - Feedback sensors.
- (ii) Explain the term *subtractive manufacturing* in relation to CNC milling.



Question 9.

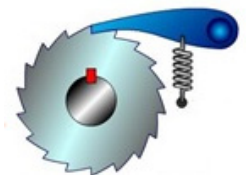
(50 marks)

- (a) The remote-controlled inspection robot shown is fitted with an adaptable camera unit.
- (i) Describe, with the aid of a diagram(s), a suitable mechanism used to tilt **or** to rotate the camera unit.
 - (ii) Outline **two** suitable uses for a remote-controlled inspection robot.

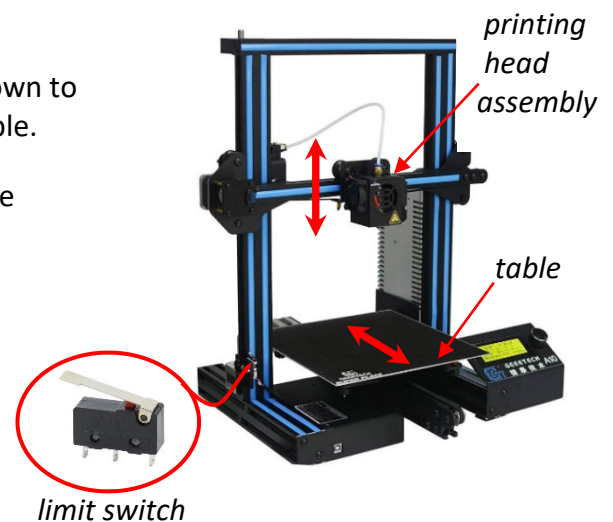


- (b) Answer **any three** of the following:

- (i) Describe, with the aid of a diagram, the operation of bevel gears.
- (ii) State **two** benefits of thermostatic control in home heating systems.
- (iii) Identify the mechanism shown opposite **and** give **one** suitable use for the mechanism.
- (iv) Describe the operation of a single acting pneumatic cylinder.
- (v) Outline the operation of a capacitor.



- (c) Various mechanisms are used in the 3D printer shown to control the movement of the printing head and table.
- (i) Describe, with the aid of a diagram(s), a suitable mechanism which will allow the printing head assembly to move up and down.
 - (ii) Outline the function of the limit switch shown on the 3D printer.



OR

- (c) An Irish company *EnergyServ*, specialises in the design and installation of solar carports.
- (i) Outline **two** benefits of the solar carport shown.
 - (ii) Describe how solar energy can provide electrical power to the vehicle shown.



Leaving Certificate – Higher Level

Engineering – *Materials and Technology*

Thursday, 5 June

Morning 9:30 – 12:30